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SURFACE WATER BIOMONITORING PROGRAM

Clean Water Act Division

EG&G ROCKY FLATS

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BIOMONITORING PROGRAM

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this biomonitoring report is to describe the biomonitoring program under development in the Clean Water Act Division (CWAD).

1.2 SCOPE

The Rocky Flats Plant (RFP) manages 150 million gallons per year of non-process water. The surface water management at RFP focuses on the domestic raw water sources of Ralston Reservoir and the Boulder diversion and the waters of three drainage systems that receive runoff from the developed facilities area and the undeveloped physiography. The biomonitoring program goals for these surface waters include addressing regulatory requirements for normal and emergency operating conditions and protecting the aquatic environment. This report includes a description of the domestic surface water system, methods for biologic testing, sampling locations, and the RFP personnel that will be involved.

1.3 GOALS

1.3.1 Regulatory Requirements

The Clean Water Act (CWA) of 1977 (Pl 95-217) sets national effluent limitations and water quality standards and establishes a regulatory program to ensure enforcement. In Colorado, discharge permits for federal facilities, such as RFP, are issued by EPA. Discharge from the RFP Sewage Treatment Plant (STP) is regulated under a National Pollutant Discharge Elimination System (NPDES) permit. The State of Colorado also sets water quality standards for receiving streams and bodies of water. They have also submitted their aquatic life biomonitoring regulation to EPA for review as a revision to the state's authorized NPDES program. The RFP has an extensive and complex water monitoring program designed to demonstrate compliance with DOE Order 5400.1, DOE Order 5480.1B, the DOE memorandum of August 5, 1985, and the RFP NPDES Permit CO-0001333.

The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) and the CWA were enacted "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101[a]), and contained specific or implied requirements for the collection of biomonitoring data in at least 15 sections. The RFP has agreed in the NPDES Federal Facilities Compliance Agreement (FFCA-CWA-90-1) to analyze final effluent samples from the STP, A-4 pond, B-5 pond, and C-2 pond using the EPA approved Whole Effluent Toxicity (WET) test. In the FFCA Chromic Acid Incident Plan and Implementation

Schedule, action item #18 states "A need exists to evaluate state-of-the-art, real-time monitoring of the influent and effluent to the Sewage Treatment Plant for hazardous solutions."

1.3.2 Protection of the Environment

Although measurement of standard chemical water quality variables and limited frequency acute toxicity tests are the regulatory approach, the "chemical, physical, and biological integrity of the Nation's waters" is not necessarily protected. A chemical insult to the aquatic environment depends on several factors, including the 1) physical and chemical properties of the chemical and its transformation products; 2) concentrations and duration of inputs (acute or chronic, intermittent spill or continuous discharge); 3) properties of the ecosystem that enable it to resist changes which could result from the presence of the chemical or return it to its original state after the chemical is removed from the system; and 5) location of the ecosystem in relation to the release site of the chemical. Toxic effects in an aquatic environment may include lethality and sublethal effects such as changes in growth, development, reproduction, pharmacokinetic responses, pathology, biochemistry, physiology, and behavior (Rand and Petrocelli 1984).

At RFP there are a variety of chemicals that may make their way into the sanitary sewer system that are similar to the everyday compounds that comprise the wastewater of Publicly Owned Treatment Works (POTWS). RFP waste streams are made up of domestic waste streams with sources such as cafeterias, restrooms, and showers and non-domestic waste streams (miscellaneous waste streams) such as film processing, janitorial activities, industrial equipment cleaning, and cooling tower blowdown. There are also herbicides and chemical compounds such as nitrate and tri-chloroethene, that, through groundwater and surface water run-off routes, make their way to the surface water holding ponds.

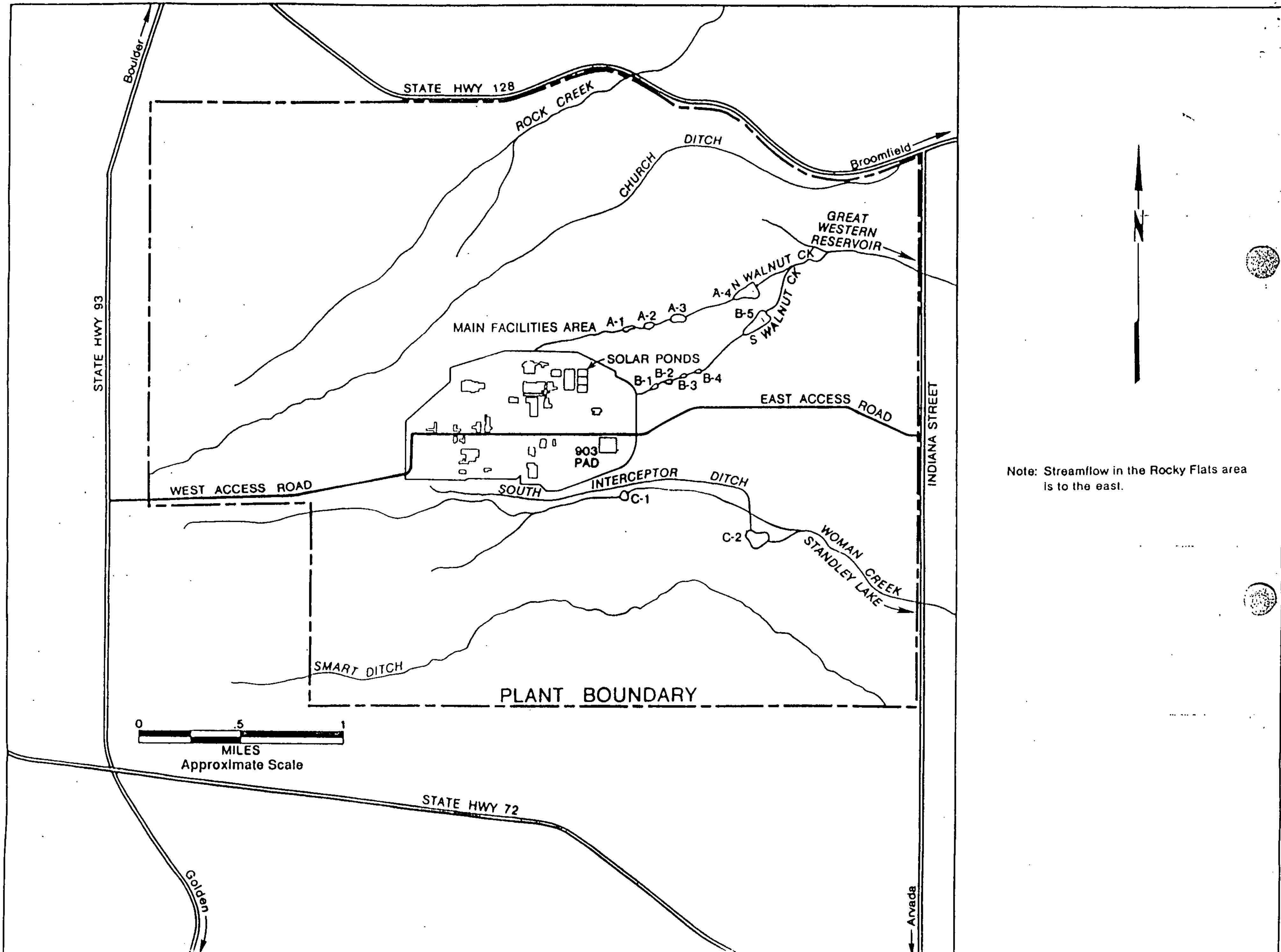
Determining the concentration of each of these compounds and relying on toxicity data derived from Ceriodaphnia and fathead minnow tests monthly or quarterly, does not account for the synergistic and antagonistic effects of the whole effluent. It is much more effective to perform more than one biological assay on a more frequent schedule.

2.0 LOCATION AND SETTING OF SURFACE WATER

The surface water system of concern includes the upstream raw water sources, the surface water features of Rocky Flats, and downstream surface waters (Figure 1). The upstream surface water features relevant to Plant operations include the South Boulder Diversion Canal, Rocky Flats Lake, and the Upper Church and McKay ditches. There are also gravel and clay mining operations upstream of Rocky Flats. Overflows or runoff from these features have the potential to bring suspected contaminants onto Rocky Flats property, and affect the water quality and flow in Walnut, Woman, and Rock Creeks.

Rocky Flats Lake is a privately leased reservoir east of State Highway 93 and south and west of the Plant boundary. This reservoir supplies water to the Smart Ditch, which crosses the southern buffer zone of Rocky Flats.

Figure 1 Holding Ponds and Liquid Effluent Water Courses at the Rocky Flats Plant.



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The South Boulder Diversion Canal is located west of the Plant boundary, and supplies water to Ralston Reservoir five miles south and west of the Plant site, and to Rocky Flats Lake. A headgate on the South Boulder Diversion Canal near the west access road to Rocky Flats supplies raw water to the Rocky Flats facility.

Surface water features of Rocky Flats include: (1) North and South Walnut Creek; (2) Woman Creek; (3) the Upper Church Ditch; (4) McKay Ditch; (5) Mower Ditch; (6) the South Interceptor Trench which feeds Pond C-2; (7) the landfill Pond; (8) ponds of the A- and B-series; and (9) the C-series ponds and Rock Creek.

Downstream water features of the RFP include Walnut Creek which, prior to 1990, drained into Great Western Reservoir, a drinking water supply. Woman Creek also drains into a drinking water supply reservoir (Standley Lake). The Mower Ditch diverts irrigation water from Woman Creek below Pond C-2 to Mower Reservoir, located to the east of Rocky Flats. Further downstream, Big Dry Creek and the South Platte River flow west and north.

3.0 BIOMONITORING METHODOLOGY

3.1 OVERVIEW

RFP has been faced with four problems: the great number and diversity of potentially toxic substances; the difficulty of detecting and monitoring toxics; the lack of accurate toxicological data for many compounds; and the difficulty of predicting interactive effects in complex mixtures of toxic substances. Biologic toxicity testing is an effective way to determine whether this combination of chemicals is disrupting the the chemical and biological integrity of our surface water.

Biomonitoring methods can be classified into two categories: ecological surveys and toxicity testing. Ecological surveys may use indicator species, assessments based on the composition of biological communities, numerical diversity and indexes, or all of these. By making comparisons between affected and control areas, ecological surveys can indicate the health of a water body exposed to pollutant loadings (Roop and Hunsaker 1985).

3.2 ECOLOGICAL SURVEYS

The ecological surveys on RFP surface water include a study by Paul Kugrens, Ph.D from Colorado State University (CSU). Kugrens began a study in the A-, B-, and C-series ponds in 1989 to monitor algal species changes and population fluctuations. In addition, Kugrens determined what contributions the algae make on BOD values in B-3 pond. Kugrens found that the algae populations of A-3 and A-4 were minimal and lacked diversity. Sandra Spence of EG&G Technology Development is conducting a more detailed study of the biological conditions of A-3 and A-4 ponds in 1991 to determine the health of the aquatic system. Kugrens will continue his studies on B-5, A-3, and A-4 as supplemental information to Spence's work.

3.3 TOXICITY TESTING

Biomonitoring is now routinely being included as a NPDES permit requirement. Standardized methods are available only for acute and chronic single-species tests (Roop and Hunsaker 1985). There are different surface water conditions and treating processes at RFP that are better suited to specific biologic toxicity testing. Each of these conditions and processes requires either short term characterization or long term monitoring. Therefore, several methods with varying duration will be used to address the specific surface water quality concerns.

The toxicity testing methods used at RFP include the periodic WET tests that fulfill the NPDES FFCA requirement for the pond effluent , the on-line respirometer sampling the STP influent and aeration basin that fulfills Judgement of Need #18 of the FFCA Chromic Acid Incident Plan and Implementation Schedule, and the Microtox that will be used to determine the baseline toxicity of the incoming raw water and various RFP waste streams and also used during emergencies.

3.3.1 WET Test

The EPA WET test includes a 48-hour replacement static test using Ceriodaphnia sp. and acute 96-hour replacement static tests using fathead minnows (Pimephales promelas). The acute replacement static toxicity tests are conducted in conformity with procedures outlined in the latest edition of "Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms", EPA/600/4-85/013 (Revised

March 1985) and the "Region VIII EPA NPDES Acute Test Conditions - Static Renewal Whole Effluent Toxicity". The sampling was to occur during pond discharge "monthly for six consecutive months and quarterly thereafter until the date that the renewal NPDES permit becomes effective". None of the terminal ponds is discharged continually and a discharge sample cannot be taken monthly. Therefore, during the scheduled sampling time and independent of pond discharge a water sample is taken within the pond for a WET test analysis. Monthly WET tests have been performed by a contract lab, T.H.E. Consultants, for March through October of 1990 and January through March of 1991.

3.3.2 Respirometer

As a conservative management practice and in answer to #18 Judgement of Need in the FFCA Chromic Acid Incident Plan, the baseline toxic or non-toxic characteristics of our surface water is of concern. It is important to create tools that can help determine water quality in normal and emergency conditions. These tools need to provide a way to isolate emergency toxicity incidents. In response to this, the RFP CWAD will be implementing improvement projects which include using a respirometer to monitor potential toxicity in the STP influent stream.

In order to detect the intrusion of a biologically toxic compound into the STP, an Arthur Tech-Line Automatic Respirometer has been installed in Building 995. The on-line respirometer automatically samples the influent wastewater stream and the aeration basin outlet. Each sample type is conducted by separate piping into the respirometer sample chamber. The respiration rate of microorganisms in the sampling chamber is measured and the data automatically plotted. This data provides an indication of microorganism activity and facilitates detection of a biologically toxic compound in the STP influent. Contingency plans for responses to respirometer detected toxicity are under development. When the data base is completed and the oxygen uptake rate changes are better understood, the respirometer will continue to provide information to the STP operators on changes in conditions.

The CWAD is developing a respirometer data base that will not only provide a way to identify the intrusion of a toxicant but will also provide a functional role for STP operations using an on-line sampling system. Once an average respiration rate and normal fluctuations are identified, it is proposed that another respirometer will provide timely information on a change in treatment plant conditions, microorganism viability, and aeration tank effectiveness. The STP operators will be able to observe and interpret the changes that take place in this system under various conditions through a continuous measure of oxygen uptake.

3.3.3 Microtox Toxicity Test

While the primary purpose of the Tech-Line Automatic Respirometer is early warning of biologically toxic compounds in the STP, it will also be effected by changes in pH and dissolved oxygen, which may create stress to the resident microorganism population. Such conditions result in less than optimum waste treatment and the respirometer will be indicating reduced oxygen uptake.

To confirm whether toxicity is involved, respirometer monitoring at the STP will be supplemented by a Microbics Corporation Microtox Model 500. The Microtox provides a biological test which detects and measures toxicity. The test provides reproducible results within 30 minutes, and is capable of processing large numbers of samples within a short period of time. The standard test consists of measuring the light output of a photoluminescent marine bacteria and then measuring the change in light output once the water sample is added. The results are represented in the form of an EC_{50}.

The Microtox will be used to test the surface waters upstream and downstream of the STP to locate possibly toxic sources and evaluate the condition of the ponds. Further Microtox analysis on the STP influent will provide a means to correlate the responses of the respirometer and the Microtox.

The Microtox testing will be used to quantify toxicity, if it exists, in wastewater streams and surface waters under normal conditions in 1991 and 1992. Under emergency conditions, Microtox test results will provide an immediate determination of the extent of intrusion into STP unit processes, and will facilitate identification of the source of toxicity in the waste streams above the STP.

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3.4 SAMPLING LOCATIONS

In any type of biomonitoring program, it is important to run more than one type of test on a sample to confirm and interpret the results. There are many parameters that affect the viability of a biologic system, making it necessary to compare toxicity tests. The RFP biomonitoring system will provide for overlap between the EPA WET test, algae ecosystem surveys, respirometer, and Microtox (Table 1).

The Microtox toxicity test provides great flexibility in sampling location. Water samples can be taken from anywhere at RFP, while the toxicity test is performed at a centralized laboratory. Microtox samples will be compared to the on-line respirometer at the STP influent/effluent, algae ecosystem investigations on ponds A-3, A-4, and B-5, and the WET tests on the STP effluent, A-4 pond, A-4 effluent, B-5 pond, and C-2 pond (Table 1). The WET test and algae ecosystem surveys in A-4 and B-5 will provide overlapping comparisons for these locations. The comparison of the Microtox results to other biomonitoring methods will provide a better picture of toxicity at the surface water locations. The Microtox will be used for the surface water characterizations of raw water, the Protected Area (PA) and non-PA waste streams at the equalization basins, A-1 by-pass, various groundwater seeps, flumes, incidental waters, suspected emergency toxicity, and off-site adjacent facilities.

TABLE 1

Biomonitoring Test Comparisons

TEST LOCATIONS	WET Test	Algae Surveys	Respirometer	Microtox
				Raw Water
				Equalization Basins
			STP Influent	STP Influent
			STP Aeration Basin	
	STP Effluent			STP Effluent
				W. of A1 Bypass
				A1 Bypass
				A1
				A2
		A3		A3
	A4	A4		A4
				B1
				B2
				B3
				B4
	B5	B5		B5
				C1
	C2			C2
				Seeps
				Flumes
				Offsite Adjacent Facilities
				Incidental Water
				Emergency Toxicity Locating

3.5 SAMPLING DURATION AND FREQUENCY

The quality of natural and industrial waters varies over time due to different environmental conditions (precipitation, temperature, pH, and light) and the addition of chemical compounds. These variations result in chemical, biological, and physical changes that can alter the water quality and, therefore, results of toxicity tests.

In order to identify when seasonal changes have contributed to a change in water quality, most of the toxicity testing for surface water characterization purposes will occur over one year (Table 2, 3 and 4). It is possible that the first year of testing will not provide interpretable data, and one or more additional years of testing will be necessary for surface water characterization and ecosystem surveys. The toxicity tests that will continue beyond one year include the EPA WET Test and Respirometer oxygen uptake.

In some cases the frequency of sampling is dependent on the regulation requirement or equipment sampling frequency (WET Test and Respirometer). The sampling frequency of the surveys and characterizations is based on providing a representative sample that will provide clues for determining the causes for fluctuation in toxicity. The ecosystem surveys will occur weekly to bi-weekly, surface water characterization samples monthly to quarterly, and groundwater seeps will be sampled two or three times over the summer during discharge times.

TABLE 2

Biomonitoring Sampling Frequency and Duration

Biomonitoring Test		Sampling Frequency	1991 CWAD Man Hours
WET test			Review only
A-4 Pond		Monthly	
A-4 Effluent		Monthly if discharging	
B-5 Pond		Monthly	
C-2 Pond		Monthly	
995 Effluent		Monthly	
Algae Ecosystem Survey			Review only
A-3	Kugrens	Bi-weekly after contract renewal	
A-3	Spence	Weekly	
A-4	Kugrens	Bi-weekly after contract renewal	
A-4	Spence	Weekly	
B-5	Kugrens	Bi-weekly after contract renewal	
Respirometer O_2 Uptake		Monitor daily until CWAD development is completed	170 hrs
STP Influent		Every 20 minutes	
STP Aeration Basin		Every 20 minutes	
STP Return Activated Sludge		Every 20 minutes	
Microtox			
WET Test Splits			96 hrs
995 Effluent		Monthly	
A-4 Pond		Monthly	
A-4 Effluent		Monthly	
B-5 Pond		Monthly	
C-2 Pond		Monthly	
Raw Water		Weekly for 1 year	32 hrs

TABLE 2

Microtox (continued)

STP		
Influent	Weekly for 1 year	32 hrs
Effluent	Weekly for 1 year	32 hrs
		64 hrs
Waste Streams Characterization		
Equalizaton Basin PA	Monthly for 1 year	8 hrs
Equalization Basin Non-PA	Monthly for 1 year	8 hrs
		16 hrs
Surface Water Holding Ponds		
A-1 Bypass	Quarterly for 1 year	3 hrs
W. of A-1 Bypass	Quarterly for 1 year	3 hrs
		6 hrs
A-1	Monthly for 1 year	8 hrs
A-2	Monthly for 1 year	8 hrs
A-3	Monthly for 1 year	8 hrs
A-4	Monthly for 1 year	8 hrs
B-1	Monthly for 1 year	8 hrs
B-2	Monthly for 1 year	8 hrs
B-3	Monthly for 1 year	8 hrs
B-4	Monthly for 1 year	8 hrs
B-5	Monthly for 1 year	8 hrs
C-1	Monthly for 1 year	8 hrs
C-2	Monthly for 1 year	8 hrs
		88 hrs
Seeps	During Precipitation events for 1 year	Variable
Offsite adjacent facilities	Begin program in 1993	
Applicable sites during precipitation events	Begin program in 1993	
New chemicals tests	Begin program in 1993	
Incidental Waters	Variable	Variable

Emergency Response — As Needed

Microtox Samples
Compare Respirometer print-outs
Test pH, NO_3, DO, Sulphate,
Chloride, and Phosphate

Total Scheduled Hours = 472

Table 3

Biomonitoring Testing Schedule
1991

Location	January	February	March	April	May	June	July	August	September	October	November	December
<u>Wet Test</u>												
A-4 Pond												
A-4 Effluent												
B-5 Pond												
C-2 Pond												
995 Effluent												
<u>Algae Ecosystem Survey</u>												
A-3 Kugrens												
A-3 Spence												
A-4 Kugrens												
A-4 Spence												
B-5 Kugrens												
<u>Respirometer O_2 Uptake</u>												
STP Influent												
STP Aeration Basin												
STP Return Activated Sludge												

Table 3 (continued)

Biomonitoring Testing Schedule 1991

Location	January	February	March	April	May	June	July	August	September	October	November	December
<u>Microtox</u>												
Raw Water												
Wet Test Splits												
A-4 Pond												
A-4 Effluent												
B-5 Pond												
C-2 Pond												
995 Effluent												
Surface Water Characterization												
Equalization Basin PA												
Equalization Basin Non PA												
STP Influent												
STP Effluent												

Table 3 (continued)

Biomonitoring Testing Schedule
1991

Location	January	February	March	April	May	June	July	August	September	October	November	December
Microtox Continued					6-10			5-9			4-8	
A-1 Bypass					☐			☐			☐	
W. of A-1 Bypass					☐			☐			☐	
						3-7	1-5		2-6	7-11		2-6
A-1					☐	☐	☐	☐	☐	☐	☐	☐
A-2					☐	☐	☐	☐	☐	☐	☐	☐
A-3					☐	☐	☐	☐	☐	☐	☐	☐
A-4					☐	☐	☐	☐	☐	☐	☐	☐
					13-17	10-14	8-12	12-16	9-13	14-18	11-15	9-13
B-1					☐	☐	☐	☐	☐	☐	☐	☐
B-2					☐	☐	☐	☐	☐	☐	☐	☐
B-3					☐	☐	☐	☐	☐	☐	☐	☐
B-4					☐	☐	☐	☐	☐	☐	☐	☐
B-5					☐	☐	☐	☐	☐	☐	☐	☐
					20-24	17-21	15-19	19-23	16-20	21-25	18-22	16-20
C-1					☐	☐	☐	☐	☐	☐	☐	☐
C-2					☐	☐	☐	☐	☐	☐	☐	☐
Toxichromo Splits												

Table 4

Biomonitoring Testing Schedule
1992

Location		January	February	March	April	May	June	July	August	September	October	November	December
Wet Test													
A-4 Pond													
A-4 Effluent													
B-5 Pond													
C-2 Pond													
995 Effluent													
Algae Ecosystem Survey													
A-3	Kugrens												
A-3	Spence												
A-4	Kugrens												
A-4	Spence												
B-5	Kugrens												
Respirometer O_2 Uptake													
STP Influent													
STP Aeration Basin													
STP Return Activated Sludge													

Table 4 (continued)

Biomonitoring Testing Schedule

1992

Location	January	February	March	April	May	June	July	August	September	October	November	December
Microtox												
Raw Water												
Wet Test Splits												
A-4 Pond												
A-4 Effluent												
B-5 Pond												
C-2 Pond												
995 Effluent												
Surface Water Characterization												
Equalization Basin PA												
Equalization Basin Non PA												
STP Influent												
STP Effluent												

Table 4 (continued)

Biomonitoring Testing Schedule
1992

Location	January	February	March	April	May	June	July	August	September	October	November	December
Microtox Continued												
A-1 Bypass		3-7 ☐										
W. of A-1 Bypass		☐										
A-1	6-10 ☐	☐	2-6 ☐	6-10 ☐								
A-2	☐	☐	☐	☐								
A-3	☐	☐	☐	☐								
A-4	☐	☐	☐	☐								
B-1	13-17 ☐	10-14 ☐	8-12 ☐	12-16 ☐								
B-2	☐	☐	☐	☐								
B-3	☐	☐	☐	☐								
B-4	☐	☐	☐	☐								
B-5	☐	☐	☐	☐								
C-1	20-24 ☐	17-21 ☐	16-20 ☐	19-23 ☐								
C-2	☐	☐	☐	☐								
Toxichromo Splits												

3.6 CORRELATIONS AND STATISTICAL ANALYSES

The CWAD of the RFP will be using the Microtox test to quickly identify potential toxic streams requiring further investigations. The test has been used by researchers to identify wastewater toxicity and as a comparison between this assay and other bioassays. The CWAD biomonitoring program will include a comparison between Ceriodaphnia acute toxicity values and the Microtox test. The duplicate results from sample splits will be statistically compared using a paired "t" statistic. Second, seasonal change may cause changes in the data over the year. Therefore, when the data is compiled, an appropriate statistical test will be chosen to measure the variability. Third, linear regression statistics will be used to establish a positive linear relationship between the results for the two bioassay methods. Depending on the data this may include a regression of the log values in predicting the Ceriodaphnia LD_{50} response from the Microtox test values (EC_{50}).

The Respirometer samples the influent to the Sewer Treatment Plant every 20 minutes. The influent samples taken for the Microtox will be reviewed to determine whether there is a correlation on bacterial responses with the Respirometer. If possible, the duplicate results will be statistically compared using a paired "t" statistic.

4.0 PERSONNEL INVOLVED

The Biomonitoring program is being planned and monitored within the CWAD of Environmental Management by the Permitting & Compliance, and

Operations & Surveillance programs. The Surface Water Upgrades program is providing engineering support. The Environmental Monitoring and Assessment Division (EMAD) will be providing water sampling for some of the toxicity tests, Statistical Applications Division will provide statistical support, Waste Programs and Industrial Hygiene will provide guidance on the disposal of waste liquids and containers used in sampling and toxicity testing.

The Respirometer is located at the STP, and will be loosely monitored by the operators during the development stage. This will include making observations on unusual conditions that may need the attention of the CWAD. After the development of toxicity monitoring capabilities, it may be necessary to install another Respirometer cylinder to run in tandem and provide operational information. This will allow continual 20 minute sampling of the STP influent for toxicity monitoring purposes, and separate sampling of the aeration basin for operational purposes. The respirometer will then be fully monitored by the STP operators with technical support from CWAD.

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